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THE BACTERIOLOGICAL SELF-HELP SURVEY FOR RECREATIONAL LAKES

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Ontario
Ministry of the Environment

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THE BACTERIOLOGICAL SELF-HELP SURVEY FOR RECREATIONAL LAKES

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MICROBIOLOGY REPORT

LABORATORY SERVICES BRANCH
ONTARIO MINISTRY OF THE ENVIRONMENT

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SUMMARY

Eighteen lakes in Southern Ontario were examined for bacteriological water quality with the assistance of cottager associations. This self-help program ran from 1971 to 1975 inclusive. The results showed that lake water quality was generally good, but low levels of contamination were noted, mainly at inflowing streams. Where the possibility of contamination of human origin arose, marinas, trailer parks, and river mouths were implicated. Higher levels of total coliforms were isolated in lakes of higher trophic status as measured by Chlorophyll a (Chl a) levels. This relationship was expressed as a regression of total coliforms on Chl a so that:

$$LOG_{10} TC \text{ (Summer)} = 0.77 + 2.23 \, LOG_{10} \text{ Chl a} \quad (R = 0.7242).$$

The bacteriological self-help program was useful in screening levels of pollution in lakes, and in responding to requests for lake surveys from cottagers, and it is recommended that it continue in Regions of Ontario which have the required laboratory facilities, and that, whenever possible, it be carried out with the trophic status self-help program (secchi-disc/ (Chl a).

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INTRODUCTION

The bacteriological self-help program for Recreational Lakes was established by the Ontario Water Resources Commission with interested cottager associations in 1971, and continued by the Ministry of the Environment since then to assist cottage owners to determine the bacteriological water quality of lakes. The self-help investigations can be useful in indicating possible contamination sources which require a subsequent M.O.E. survey, or in assuring interested cottagers that the bacteria present are from natural sources without health hazards. The standard water quality indicators, total coliforms, fecal coliforms, and fecal streptococcus were determined in the self-help lake samples. The most important of these bacterial indicators of water quality is the fecal coliform density. These bacteria are largely Escherichia coli, an inhabitant of the intestines of man and animals, and are accompanied by fecal streptococcus in varying proportions depending on source. High levels of fecal coliforms without a corresponding level of fecal streptococcus may indicate some human contamination and an accompanying health hazard to users of the water. Microbial contamination by raw or inadequately treated sewage does not significantly change the appearance of the water but poses an immediate public health hazard when the water is used for drinking or swimming. The program ran from 1971-1975 inclusive and was suspended in 1976 for reasons of economy. This report examines the results of the program and assesses its benefits.

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METHODS

Selection of Lakes

The lakes studied were selected on the basis of representations made by cottager's associations, and were all fairly close to Toronto, and, as expected, most were located in the Central Region of Ontario (Table 1). A self-help program to determine the trophic status of lakes by means of secchi-disc/Chl a measurements was carried out by the Ministry of the Environment in the same period. These surveys were rarely carried out jointly with bacteriology, but, whenever possible, the results of both programs are compared in this report.

Survey

Cottagers visited the Toronto Laboratories for instruction in sampling, and supplied an outline map of their lake on which sampling locations were drawn. The sampling sites allowed for monitoring of inlets and the outlet, a midlake location, and a number of cottaged areas of interest to the cottagers association. The sampling points totalled about 15 to 20 for each lake. Samples were taken a metre from the surface 10-15 meters from shore and depth samples were omitted.

The cottagers were requested to sample all locations each Sunday for one spring and one summer month. The samples were chilled in a cooler and delivered to the Toronto Laboratories where they were analyzed each Monday morning. The M.O.E. supplied sampling equipment, sterile bottles, and an analysis of the sample while the cottagers supplied a boat, cooler, transportation and their time and interest.

Bacterial Enumeration

1) Total coliform bacteria (TC) were determined as a count of dark red colonies with sheen grown on a membrane filter with M-endo LES agar (1).

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TABLE I

BREAKDOWN BY REGION OF
BACTERIOLOGICAL SELF-HELP
LAKE REPORTS 1971-1975

Region*	Central	Southeastern	Northeastern
Year			
1971	Kennisis Harcourt Park	Kamaniskeg	Hodson Sand Bay (Shebeshekong)
5	2	1	2
1972	Oxtongue		Clear (Perry)
2	1		1
1973	Oak Riley		
2	2		
1974	Troutspawn Twelve Mile Bay Sturgeon Bay		Hodson
4	3		1
1975	Round Oxtongue	Kamaniskeg (Barry's Bay)	Healey Kapikog Wahwashkesh
6	2	1	3
TOTALS			
19	10	2	7

* There was no participation from the Southwestern, West Central, or Northwestern Regions

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2) Fecal coliform bacteria (FC) were determined as a count of acid producing yellow to yellowish-green colonies grown on a membrane filter with McConkey broth at 44.5°C.
3) Fecal streptococcus bacteria (FS) were obtained from a count of pink to red colonies grown on a membrane filter with M-enterococcus agar (1).

Data Processing

Geometric mean values for each sampling location and for the lake were calculated on a monthly basis. The method of sample collection usually made the data unsuitable for statistical evaluation, for example, by analysis of variance, as it is done for the regular M.O.E. recreational lakes surveys. The frequency of sample collection made the mean bacterial values unsuitable for direct comparison to the Recreational Criteria (2). The values for the criteria are quoted in Table II. A few exceptions to this were found, for example Round Lake and Barry's Bay 1975.

Form of Reporting

M.O.E. reports were drafted for all surveys where a reasonable amount of data was collected, then delivered to the cottager's pollution committee for distribution to interested cottagers. Bacteriological information of general interest to cottagers was added to the report. The list of self-help reports is given in the Appendix.

Chlorophyll

Data on chlorophyll levels in the lakes were taken from reports of the trophic status self-help program. The Chl a analyses were not usually done in the same year as the analyses for bacteria, however, it was the only data available and year to year variations were not considered large (5).

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TABLE II

BACTERIOLOGICAL CRITERIA FOR PRIVATE WATER SUPPLIES* — RECREATIONAL CRITERIA*

Bacteria	Incubation Temperature	Permissible Criteria: Chlorination only	Permissible Criteria: Chlorination & Filtration	Desirable Criteria: No Treatment	Levels not to be Exceeded
Total Coliforms	(35°C)	100/100 ml	400/100 ml	0/100 ml	1000/100 m l
Fecal Coliforms	(44.5°C)	10/100 ml	40/100 ml	0/100 ml	100/100 ml
Fecal Streptococci	(35°C)	1/100 ml	4/100 ml	0/100 ml	20/100 ml
Total Bacteria	(20°C)	1,000/100 ml	4,000/100 ml	10/100 ml	-
Clostridia (in water)	(35°C)	0/100 ml	4/100 ml	0/100 ml	-

* For conditions of sampling and further details see: -
Guidelines and Criteria for Water Quality Management in Ontario, MOE 1975

RESULTS AND DISCUSSION

The geometric mean bacterial densities for the lakes in a spring and a summer month are shown in Table III. Bacterial densities exceeded the Recreational Criteria (2) once in 1973, when summer total coliform levels in Riley Lake were unusually high.

The levels of fecal bacteria increased in the summer and, although these levels were low, it followed that the water in none of the lakes surveyed was suitable for drinking without prior sterilizing treatment. The bacteriological criteria for private water supplies are quoted in Table II. The location and levels of contamination in the lakes are listed in Table IV. The most frequent sources of contamination were inflowing streams which carried rural stormwater runoff into the lakes. The levels of contamination were much lower than the Recreational Criteria, and it was concluded that the recreational water quality was not greatly impaired. The sources of bacterial inputs were considered to be largely of animal origin or mixed sources washed in with stormwater. A few locations showed signs of low levels of contamination of human origin. Trailer parks, marinas and river mouths were implicated where the possibility of contamination of human origin arose (Table IV). The type of source of contamination was evaluated by means of the FC/FS ratio (3). The interpretation of this ratio can only be carried out reliably when the bacteria are collected within 24 hours of their deposition at a point source. It was impossibe to determine when bacteria had been added to lake water and the FC/FS ratio was interpreted cautiously. Corroberating evidence from a visual site-examination is always advisable.

Total coliform levels were found to be correlated significantly with lake trophic status, as measured by mean summer Chl a, in lakes studied for the regular recreational lakes program (4). Such a relationship was also found for the self-help lakes where summer total coliforms and Chl a were correlated significantly ($P = 0.01$) $R = 0.7241$ (Fig. 1). A direct causal relationship between

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TABLE III

Bacterial Densities (GM/100 ml) for the Self-Help Lakes

Year	Lake	Spring (May or June)			Summer (July or August)			
		TC	FC	FS	TC	FC	FS	Chl a (µg/l)
1971	Hodson	19	1	1	37	1	2	1.5
	Kennisis	2	1	1	3	1	1	0.9**
	Kamaniskeg	8	1	1	18	1	1	NA
	Sand Bay (Harcourt Park)	-	-	-	13	2	2	NA
	Allen Lake	3	1	1	12	2	2	1.2
	East Lake	9	1	1	11	4	2	1.5
	L. Straggle Lake	3	1	1	30	3	4	1.6
	Big Straggle Lake	9	1	3	8	2	3	2.9
	Charlie George's	52	1	1	11	2	4	3.0
	Kennaway Lake	14	1	2	8	2	2	1.9
1972	Oxtongue	-	-	-	48	2	2	1.8**
	Oak	-	-	-	54	3	NA	
1973	Oak	-	-	-	19	1	5	NA
	Riley	-	-	-	4,790	2	2	11.9*
1974	Hodson	-	-	-	169	1	2	1.5
	Troutspawn	-	-	-	23	1	2	NA
	Twelve Mile Bay	-	-	-	18	1	2	1.0
	Sturgeon Bay	-	-	-	57	2	3	1.7
1975	Kapikog	-	-	-	5	1	2	0.9
	Oxtongue	-	-	-	11	3	3	1.2
	Wahwashkesh	-	-	-	7	2	2	NA
	Healey	-	-	-	9	2	1	1.6
(1975)	Round Lake	-	-	-	17	4	3	NA

NA = not available

Unmarked - 1974

* - 1973

** - 1972

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TABLE IV

Location of Low Levels of Contamination in Self-Help Lakes

LAKE		STATION	BACTERIA/100 ml FC	FS
Hodson	1971	Bay	6*	2
		Shoreline	7	7
Kamaniskeg	1971	Inflowing Stream	4	6
		Inflowing Stream	9	5
Sand Bay (Harcourt Park)	1971	Shoreline	7	11
Big Straggle		Shoreline	7	7
		Inflowing Stream	11	4
Kennaway		Shoreline	13*	4
Oxtongue	1972	Oxtongue River	12	32
		Oxtongue River	32	56
		Oxtongue River	12	8
	1975	Area from Ragged Falls	12	153
		to Mouth of Oxtongue	27	16
		River	10	14
			12	29
			16*	4
Oak	1972	Outflowing Stream	9	N.D.
		Mouth of Bay	14	N.D.
		Inflowing Stream	8	N.D.
Sturgeon Bay	1974	Mouth of River	10	84
		River (Trailer Camp Area)	24	175
Kapikog	1975	Marina	6*	2
		Public Beach	7	6
		Cottaged Area	4	3
Healey	1975	Inflowing Stream	12	12
Round	1975	Inflowing Stream	12*	2
		Trailer Camp Area	48*	16
		Inflowing Stream	27	11

N.D. = No Data

* = Possibility of some pollution of human origin

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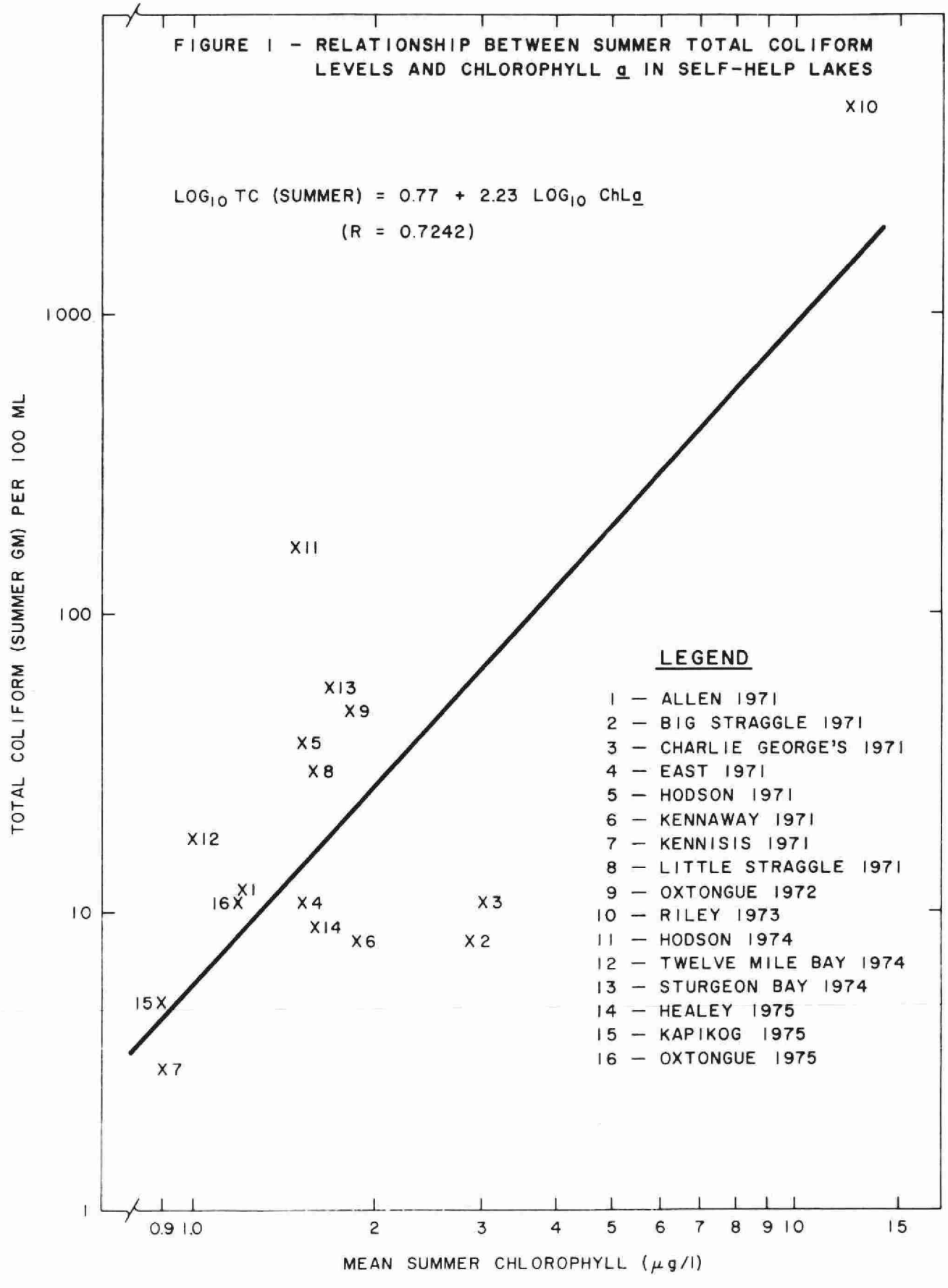
FIGURE 1 - RELATIONSHIP BETWEEN SUMMER TOTAL COLIFORM LEVELS AND CHLOROPHYLL a IN SELF-HELP LAKES



total coliforms and Chl a seems possible, but an indirect relationship where lakes of high trophic status, containing high levels of nutrients, generally support the growth of some types of coliforms, as well as algae, is equally likely. This problem is more fully discussed elsewhere (4). For this reason the high total coliform densities in Riley Lake 1973 were thought to be largely the result of a nutrient problem rather than a problem of fecal contamination and, in support of that conclusion, fecal coliform levels were found to be very low. Eutrophic lakes, however, can have other bacteriological problems such as the presence of certain types of pathogenic bacteria which appear related to the lake trophic level. A recent M.O.E. study showed that the ease of isolation of Pseudomonas aeruginosa, a bacterium which may cause ear and eye infections, increased in lakes of high trophic status (6).

It was concluded that the program was successful in responding to the requests and queries of cottagers. The results have indicated to them that the water quality was generally good. There were some similarities between the results obtained by the self-help surveys and the regular M.O.E. recreational lakes surveys, however, they are not equivalent. The principal shortcomings of the self-help data were that a direct comparison to the Recreational Criteria could not be carried out, and that the data were not easily analyzed statistically. Bacterial densities obtained at a specific location cannot be proved to be higher than those of surrounding areas without a statistical test. Experience gained with the more complete regular five-day surveys of recreational lakes was used to evaluate the self-help data. Nevertheless, this type of survey would seem to function in a screening role.

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RECOMMENDATIONS

It is recommended:

1) that the program be continued within its recognized limitations.
2) that the program be regionalized, and be carried out in regions of the province having suitable laboratory facilities. The Laboratory Services Branch will give support and advice to those who are interested in this program.
3) that the bacteriological self-help and trophic status self-help programs be carried out together where possible as their results may be complementary.

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6. Seyfried, P.L., 1976. Assessment of the Use of Bacteriological Determinants to Study the Effects of Recreational Activity/Development on Lake Water Quality. M.O.E. (In Press).

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APPENDIX

M.O.E. REPORTS FROM THE BACTERIOLOGICAL SELF-HELP PROGRAM

1) Leggatt, E.A. 1971. O.W.R.C. Bacteriological Water Quality of Hodson Lake (Three Mile Lake 1971)

2) Leggatt, E.A. 1971. O.W.R.C. Bacteriological Water Quality of Kamaniskeg Lake (1971). Self-Help Program.

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9) Hendry, G.S, Kathy Harcus. 1975. M.O.E. Bacteriological Water Quality of Hodson (Three Mile) Lake, Parry Sound (1974).

10) Hendry, G.S., W. Falby. 1975. M.O.E. Bacteriological Water Quality of Troutspawn Lake (1974).

11) Hendry, G.S., W. Falby. 1975. M.O.E. Bacteriological Quality of Twelve Mile Bay, Muskoka, Twp. of Georgian Bay (1974).

12) Hendry, G.S., W. Falby. 1975. M.O.E. Bacteriological Water Quality of Sturgeon Bay and Sturgeon River, Simcoe County (1974).

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13) Hendry, G.S., Patricia Bolton. 1976. Bacteriological Water Quality of Healey Lake, Parry Sound. 1975.

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